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REPORT

—ON A—

SYSTEM OF SEWERAGE

—FOR THE—

CITY OF BINGHAMTON, N. Y.,

—BY—

RUDOLPH HERING,

Civil and Sanitary Engineer.

BINGHAMTON:
DAILY ♦ LEADER ♦ JOB ♦ ROOMS.
1882.

REPORT ON A SYSTEM OF SEWERAGE.

To the Honorable Common Council of the City of Binghamton, N. Y. :

GENTLEMEN : — In accordance with your request, I herewith respectfully submit a r port and plan concerning a system of sewerage for your city. They are based on a careful examination of the locality and on the topographical and other data furnished to me by your officers.

Very respectfully,

RUDOLPH HERING.

REPORT.

It will not be necessary for me to urge upon you the desirability of establishing a systematic plan f r the removal of sewage and rainwater from your city, inasmuch as your taking steps to this end shows a recognition of the fact.

The constantly increasing amount of water used for domestic purposes has produced a correspondingly greater quantity of waste fluids, which from their decomposable nature threaten serious injury to health, if they are not promptly removed from the neighborhood of dwellings to suitable points.

Cesspools are increasing in number, and their liquid contents, permeating the loose sand and gravel under the town, tend to pollute the ground-air rising into the dwellings.

Also the floodings from stormwater are becoming more and more troublesome, especially from the fact that topographical peculiarities and spreading improvements cause great accumulations in certain districts, which not only injure the use of property but also its sanitary condition.

It is therefore clear that the time has fully arrived when steps should be taken to prevent a further increase of soil pollution in the most densely inhabited parts of the town, and also to provide for a proper removal of surface water from the improved areas. I shall then at once proceed to discuss the main points governing the design of a system of sewers which will collect and remove the sewage and storm water to such points and under such conditions as will satisfy all sanitary demands in the most expedient manner.

OUTFALLS.

The first question to be considered is the proper location of the ultimate outfalls for the sewage, as the entire system will more or less depend upon it. There can be no doubt that the Susquehanna river, below its junction with the Chenango river, carries a sufficient amount of water even in dry seasons to receive the sewage of Binghamton without detriment to the town.

The Chenango river is very shallow during the summer months, and has a sluggish current and numerous shoals. Although its water could safely receive a small amount of sewage into its current, yet it would be seriously polluted by all that naturally drains into it, and much of the filth would strand upon the shoals and decompose, spreading foul air over the neighboring grounds. Its con-

dition is already such that any increase of foul matter entering it could be but slight without causing this objectionable feature.

The same can be said of the Susquehanna river above its junction, applying only in a less degree. The mouth of the present State street sewer is sufficient evidence of the impropriety of discharging sewage upon shoals which abound along the north side of the river. Neither would it be proper to discharge sewage into the pool above the dam, where the current is so slight that nearly all of the suspended matter would be permanently deposited. Below the dam and near the southern side of the river there is a good current, which can receive a large amount of sewage before giving trouble.

Holding these conditions in view, I have concluded to place the ultimate outfalls for the entire city at the junction of the rivers as follows :

One, discharging the sewage of the First ward, is at the foot of Lovers' Lane where the current from the Chenango river approaches the shore and would carry the sewage towards the centre of the Susquehanna river. An outfall below Lovers' Lane is objectionable on account of the shoals along the north bank of the river as far down as the city limits.

Another outfall, delivering the sewage of the Second, Third and Fourth wards, is at the point of land between the two rivers, which allows it to be carried away between their uniting currents.

A third outfall, discharging the sewage from the Fifth ward, is located just above the mouth of Park creek, and near the main current of the river.

At these points the entire sewage of the city should be ultimately delivered, and the alignment of the outfall and the main sewers should be arranged accordingly. Yet it will not be necessary to carry all of the sewage to them at present. Temporary outfalls, as long as the quantity of sewage is not great, are permissible further up the river, as already suggested, thus saving for a time the expense for several of the outfall sewers. For instance, the eastern part of the Fifth ward can be safely drained for many years into the channel below Rockbottom dam. The sewer on Carroll street can for some time discharge into the river at its foot, if the sewage is taken well out into the river in iron pipes. The northern part of the First ward can drain into the current below the Suspension bridge, also for some time, as well as the small sewer at the foot of Main street.

While I have considered it proper, for economical reasons, to advise a temporary discharge into the rivers at a few points where it will later become objectionable, I would greatly urge the immediate prohibition of the dumping of garbage and other foul rubbish along the banks of the rivers in the town. Such matter should always be carted to a distance, as its bulky nature prevents it from being carried away by the currents. It remains and decomposes on the banks or on the shoals, calling forth far more serious consequences than can arise through the temporary discharge of a small amount of sewage into the current of the river.

GENERAL SYSTEMS.

The next question to be answered concerns the general systems to be used for removing the waste and storm waters. Generally speaking there are two in common use : the "Combined" system, where all street water and sewage are carried away in the same sewers, and the "Separate" system, where they led into different channels. I shall not take up space and time in stating the particular merits or disadvantages of each.* It

*NOTE.—A full examination of the relative preference and applicability of the different systems is contained in my Report to the National Board of Health, on "The Results of an Examination of Several Sewerage Works in Europe, 1881."

will suffice to state that their preference is dependent upon local conditions, but not on any supposed differences in sanitary effects, none of which have as yet been observed. The most perfect and most satisfactory of larger works now in existence are those where rainwater and sewage enter the same channels. But small towns are as a rule better served by the "separate" system. Both can, however, be applied together in the same town, and the extent of each is simply a matter of expediency and cost.

The conditions presented in the city of Binghamton are such, that while provision should be made for the reception of sewage on every street, the storm-water can to some extent flow away entirely on the surface But there are localities where it also must be removed underground, and it then becomes a question whether it should be taken into the sewers or into separate channels.

In both cases the entrance of silt and gravel will have to be prevented as much as possible, particularly in sewers, as much of it would deposit and retain the foul matters also. Yet this care is almost as necessary for the channels carrying only the street water, as the rubbish, horse manure and filth washed into them sometimes makes them as foul as a sewer.

In general, the relative economy of the two methods for a particular district can be determined by the circumstance as to whether the removal of rainwater will have to be practically as deep as that of the sewage. If this is the case one channel for both purposes will be less expensive. Again, if a combined sewer requires but a little greater excavation than one for sewage alone, it will ordinarily also cost less than to build two separate sewers.

It has been the common custom, where separate systems were used, to admit everywhere with the sewage also at least some of the rain water from the roofs. And this has been done for the following reasons :

First.—While much of the water falling upon the gardens and streets is absorbed and evaporated, nearly all of the roof water flows off and reaches the streets. To lead it away under ground will therefore materially diminish the amount running through the yards and in the gutters. This relief to private premises though not affecting the sanitary question is usually considered very desirable. It is quite frequent that we find a sub-surface removal of rainwater, where sewage removal is not yet thought of.

Secondly.—The entire exclusion of roof water from sewers necessitates the construction of two separate drains from the houses, if it is to be taken away under ground. While this adds expense to the owners, it has also been found a source of annoyance by the maintaining of two pipes where one will do as well ; not to speak of the possibility of workmen connecting with the wrong sewer, which has been not unfrequently found to occur even in England where municipal work receives more care than here.

Thirdly.—The admission of clean water from roofs is of great benefit to the sewers, as it gives a continuous flush at times of rain, washing them out more effectually than can be done by flush tanks alone, though these are excellent aids dry weather.

Where it has been necessary to pump the sewage in order to finally dispose of it, the amount of roof water has been reduced and sometimes excluded entirely. But no such restriction is necessary in your case.

For these reasons I would recommend to you to have some of the roof water from every house led into all of the sewers. The slightly increased size of pipes for this purpose—there being no increase of excavation necessary—is repaid not only by a correspondingly less size of special rain-water channels, and a reduction of the amount of water running through the yards and in the gutters in summer, and of less ice about them in winter, but also by a better

cleansing of the main house-pipes and sewers which is a most essential consideration. After many years experience in England, this practice is now advocated there by the best authorities.

With the outfalls at the mouth of the Chenango river, and the partial or entire storm water reception in the sewers advised, economical reasons now demand that, while the foul matter must be taken to the above outfalls, the storm-water should be carried only to the nearest water-course to save the building of large sewers where it is not at all necessary.

To accomplish this, it is customary to build intercepting sewers which take the ordinary flow of sewage to the more distant outfall and allow the water from heavy rains to escape directly into the rivers or creeks. Such escapes or overflows into the natural water courses, if properly located, have not been found in the least objectionable, and their use is extensive. It is true that the storm water is mixed with sewage, but the first gush of rain flushes most of the sewage in the pipes rapidly to the outfall, and the remainder is greatly diluted before any part of it flows over into the river. The small amount of objectionable matter escaping in this way could itself not cause a nuisance, and still less when it is considered that during or soon after storms the creeks and rivers carry a largely increased amount of water, which would more readily wash any organic refuse away.

From the foregoing considerations there can be no doubt that it would be as unwise everywhere to totally separate the storm-water from the sewage as it would be everywhere to receive *all* of the stormwater in the sewers. The former plan would often complicate the arrangements, while the latter would cause unnecessary expense. A proper discrimination, based on the features of each district, appears to offer here, as in many other localities, the most economical solution of the problem in the end.

The main principles to govern the design of your works are herewith given. It is now in place to mention the main lines of the sewers.

MAIN LINES.

The two rivers divide the city into three sewerage districts, each of which requires an independent treatment.

THE FIRST WARD.—The outfall for this district is placed at the foot of Lovers' Lane, to which point all of the sewage should finally be brought.

The topography of the Ward suggests two main sub-districts. The one is situated principally north of the railroads, and is drained by a low-level sewer. The other comprises the area south of it, and is drained by a high-level sewer. I shall consider the latter first.

The shape of the ground is peculiar from the fact that much of it drains away from the two rivers, either into pockets or finally into Trout creek, making the stormwater removal an important question. I examined into several plans, one to lead the surface water along its natural course to the creek ; another, to intercept it and carry it directly to the river. The latter plan is the more expedient one, as it requires a shorter length of sewer, which at the same time could carry also the sewage of a large area, while in the other case, two separate systems draining in opposite directions would be necessary.

Starting at Main and Chestnut streets, which is the relatively lowest point that must be reached, it is possible to follow the low ground between Main street and Seminary avenue, and then either returning to Main street, discharging at its foot, or following Raymond or Oak street southward, either to discharge into the Susquehanna in a direct course, or follow the present Leroy street sewer westward.

There are serious objections to entering private property with public works, not only on account of the payment of damages for the use of the land and the

injury to property during construction, but after the works are completed a more or less frequent trespass for inspection and cleansing is necessary, should there be any points of access thereon. Wherever possible, it is therefore better to keep the sewers on public highways. To lead the sewer along Main street is useless, as it does not reach the necessary localities. I have therefore placed it upon Seminary avenue,—the only alternative.

The excavation is somewhat increased by following this street, but if the damages to be paid on private grounds are considered, the suggested plan will no doubt be even less expensive.

The line then naturally follows along Chapin street to Leroy. There is a depression on Raymond street which might be followed to the river; it is also possible to run down Oak street. But both of these lines are not only expensive, from the deep cuttings necessary, but they run through private property, and discharge on shoals in the river. A shorter and less costly line would be to follow the depression on Leroy street to Front and thence to the river on the line of the present sewer, for which the right of way is already secured. A discharge of the sewage at the proposed outfall at Lovers' Lane is then readily accomplished.

While this sewer seems to be decidedly the best for stormwater removal, its grade, height and point of discharge will also be suitable for sewage removal. The depression south of Main street is readily drained to it by sewers on Chapin, Walnut and Arthur streets. It relieves, also, the low grounds which are now drained by the sewer on Leroy street. This sewer is too high and too small for the territory proposed. But the new one could be excavated on the same line, and the pipes almost all be recovered and used again at another place, so that its removal would not be a total loss.

From Main and Chestnut streets the sewer should continue upwards to the low point at Thorp and McLean streets. To do this most economically it should be run along the low ground. I have taken the liberty to suggest a street along this line, being the continuation of McLean street, which no doubt would some day be required.

This completes the trunk sewer of the northern district of the First Ward, into which all the other sewers discharge in the nearest and best course, as will be seen from the plan. I have extended the branches, which are to receive rainwater, as far as it will likely be necessary, letting the water run to these points on the surface.

When the western and southern part of this Ward become densely built up, and more rainwater than now estimated for will run off on the surface, an additional sewer will become necessary. Its best location then is on Raymond street down to the river, intercepting the Leroy street and possibly still other sewers.

All the territory to the north and east which can not be economically reached by the main sewer just described, should drain into the low level sewer next to be examined.

Along Trout Creek the ground is very low. It can be drained to the proposed outfall at a grade only just sufficient to satisfactorily carry the sewage away. In fact, it is not practicable to drain buildings on Meadow street and a part of Mary street, without creating objectionable features for the remaining part of the system. These streets should therefore, if possible, be raised a few feet, otherwise a special means of draining them will have to be provided. The lines of the main sewers run on Clinton and Dickinson streets to Front street, where an intercepting sewer collects the sewage and takes it to the foot of Maiden Lane. Here I have located a temporary outfall which later would act as a stormwater overflow. From this point the intercepting sewer follows along the bank of the river, receiving the sewage from a few small sewers on its way, down

to the Leroy street sewer, and discharges finally at Lovers' Lane.

Although most of this intercepting sewer runs on private property, it could in no way be justly objected to, for it would cause the banks to be regulated and freed from their filth, which would considerably improve the entire shore.

The sewer continues upwards beyond Winding Way, and drains the district north of the creek. There are no unusual or troublesome features to be encountered. At one place it will be necessary to run across a block diagonally, namely from near Chestnut and Spring streets to Oak and Cemetery streets, as it is the only way of reaching the grounds near the cemetery.

The stormwater has been led into these sewers wherever it was found economical to do so. The low grounds at McLean street and towards the northeast of it should be drained by a saparate and shallow rainwater channel, discharging into Trout Creek at Mary street, as shown on the plan.

THE SECOND, THIRD AND FOURTH WARDS.—The position of the outfall for this district has already been given. Other determining elements are found in the several existing works, which are in a sufficiently good condition to be used hereafter both for sewage and rainwater. As the sewage must be prevented from entering the rivers and Brandywine creek, intercepting sewers will be necessary. The stormwater removal of this district, is important owing to the basin near Henry street, into which a large area is drained, and to the existence of a somewhat rapid descent of the ground at some places down to a more level tract, by which comparatively large quantities of water are suddenly thrown upon the latter during a rain.

To satisfy these conditions, it appears at first sight advisable to build an intercepting sewer along the Chenango river, on Water street to the suspension bridge, and thence on State street to the upper end of the town; also an intercepting sewer along the Susquehanna river, following South street as far as Liberty street, and then continuing on the latter northward.

While there can be no question with regard to the advantage and even necessity of the latter sewer, at least as far as Henry street, there are several reasons why the other line should not be followed.

1. In order to drain buildings in the northern portion of the Ward the sewer on Water street would have to be about twenty feet deep, so that it could not be used without trouble for house connections along its entire line as far as the Suspension bridge. A second sewer nearer the surface would likely have to be built for the latter purpose.

2. Its extension in the bed of the old canal to near Munsell street would also be practically useless for house drainage along its line, for nearly 3000 feet, as the sewage from Prospect avenue, Way and Chenango streets is better led into the present State street sewer.

3. The light grade necessary to reach the buildings north of Frederic street, together with the small area that would naturally drain into this sewer, would hardly make it self-cleansing, unless it were possible to divert some of the water of Brandywine creek into it to give it a continuous flush.

4. The entire territory to be reached by this sewer can as well be drained into one on Liberty street down to Henry street. As the distance to this point is much less than down State and Water streets to the outfall, the economy of using an intercepting sewer on Liberty street is apparent. And it is further increased by the consideration, that a sewer on Liberty street would be necessary in any event to drain the properties along its line, while no such necessity exists along the old canal.

5. An intercepting sewer on Liberty

street would have the advantage of stormwater overflows into Brandywine creek, which is not possible on the other line.

These considerations have caused me not to advise a sewer in the old canal bed, but an extension of the Liberty street sewer to drain the northern part of the town and to intercept all sewage that might flow into Brandywine creek. A further advantage is that the additional quantity of sewage brought down to Henry street would increase the current in the sewer below this point, and thus make the light grade, which was necessary to drain the basin on the latter street, less likely to cause deposit.

A few remarks are required with reference to this sewer below Henry street. A rather deep cutting is necessary between Pine and Hawley streets. It could be diminished by leading the sewer through private property nearer the river, where it might also be of better service for drainage.

To save distance and grade, the sewer should cross the block south of Weed's tannery from Butternut street to the bridge.

The manner in which the territory drained by this sewer is treated, can best be seen from an examination of the plan. All points where there must necessarily be an accumulation of stormwater have been reached by larger sewers in the most economical way, taking existing works into consideration. The stormwaters flowing to the low grounds at Henry street are discharged by an overflow into Brandywine creek. A second large sewer discharges at the foot of Carroll street with an overflow. The existing State street sewer is to receive a considerable portion of stormwater and to deliver it at its mouth. Overflows are further placed on Court street, Ferry street and at the foot of Eldredge street. The sewer on Water street is not only smaller but also much shallower than if it had to drain the upper part of the Third Ward. The present State street sewer is given the greatest possible usefulness by receiving the sewage from as large an area as was economical.

The Fifth Ward.—The final outfall for this district should be between the Covered bridge and the Park creek, as already mentioned. The eastern part of the Ward can be drained to this point by a sewer laid in the bed of the old canal below the dam, and following South Water street above it. Temporarily this sewer could discharge at the dam, but ultimately it would have to be carried further down. The higher grounds opposite the foot bridge can be drained immediately to the Covered bridge, as shown. There are no difficulties to be encountered in sewering the inhabited portion of this Ward.

DETAILS.

I shall still further supplement the accompanying plan by the mention of certain detailed features which are necessary to secure a successful working of the system.

Alignments.—In order that all pipe sewers which cannot be entered can yet be thoroughly examined, it is customary to build them perfectly straight between two points of access, so that a lamp held at one end of a section can be seen at the other, and thus reveal the condition of the sewer. The turns are made entirely within the manholes, in such a way as to cause no retardation to the flow. The former custom of laying pipes in a curve has no advantages, but rather tends to obstruct the current than otherwise.

In locating the branch sewers I have considered the position of lots and buildings as much as possible, so that the sewers could be put to the best use. Where a sewer does not serve the houses on both sides of the street, I have placed it on one side near the curb, so that the house connections are as short as possible.

To further decrease the length of house drains it may be found expedient sometimes to run a branch sewer through

an alley in the block instead of on the street, which might bring it much nearer to the back of the houses, where nearly all of the sewage is created.

To suit special requirements for which I had no data, it may be desirable to change the line of some of the branches. With proper precaution this can be readily done, so long as it does not affect any other part of the works.

Where branch sewers rise toward higher mains, it is often customary to carry them up completely and connect them, both to secure a better circulation of air and to enable the branch to be flushed by the water in the main. I should advise this only where it is found more economical, otherwise a man or lamp-hole placed at the head of a branch would permit both of good ventilation and flushing. The preferable plan must be determined by estimate in each case.

Shape of Sewers.—All pipe sewers have a circular shape because this form is most perfectly obtained in their manufacture. Brick sewers are to be moulded to an egg-shape, in which the ordinary flow of sewage assumes as nearly as possible a semi-circular section. Thus the "combined" sewer terminating at the foot of Leroy street should be given a much narrower invert than the intercepting sewer below this point, which should have about equal radii for invert and arch. The reason why a circular shape was not recommended for this intercepting sewer of brick, is because the ordinary flow would fill it not over one-third full, and therefore its ordinary effect would be less good, while the greater resistance, obtained when the sewer is running full, would not be serious. Pipes above 18 inches in diameter are, as a rule, too large to be perfectly shaped, and besides, unless used for an intercepting sewer, their invert is very flat for the amount of sewage that will enter them. I should, therefore, instead, prefer an egg-shaped carefully built brick sewer, which would also be less expensive.

Size.—The question of size materially affects the cost of the system. It should therefore be carefully considered. As a minimum for street sewers I have recommended a diameter of 8 inches. A smaller pipe might be large enough to take even the roof water from quite a number of buildings, but English experience of many years has shown that 6 inch pipes, although theoretically large enough, were comparatively much more liable to stoppage from obstructions which even regular flushing could not prevent, and many have been replaced by larger sizes. The excavation being the same, the increased cost would be that of the pipe alone, which is but a few cents per foot. There is no doubt, however, that in some instances where the grade is steep, a six inch pipe might answer perfectly, but this should be determined carefully in each case.

The advantages of taking away roof water in the sewers by obtaining an occasional heavy flushing, by relieving private premises of much of the rain water, and also by reducing the quantity washing down the streets, all fully justify its underground removal as one of the main objects of building sewers. I have, therefore, proportioned the sizes accordingly, and they will be found to give a considerable relief against flooding. Where the remaining storm water would accumulate to considerable quantities, there its complete reception by the sewers or by separate channels is advised.

The soil of your city is very porous and much water soaks away. As the surface becomes improved this will be less the case, but still a provision for much less rain water is necessary than in many other cities. While it is not economical to build sewers for extraordinary storms occurring only at long intervals, the sizes marked upon the plan will answer for the removal of all ordinary storm water, until your city becomes densely built up, with much roof surface and paved yards and streets, at

which time additional rain water sewers will become necessary.

GRADE AND DEPTH.—A minimum grade depends upon the amount of fluids to be conveyed away. Sewers carrying much sewage can receive a lighter grade. The low level intercepting the sewer of the First ward and the South street sewer, have the lightest grade which it is advisable to adopt without endangering its usefulness.

It is not necessary to run the sewers parallel with the street surface as you have generally been doing. The advantages gained thereby do not compare with the advantages of having an even flow and velocities which will as much as possible prevent deposit. For the projected sewer on Carroll street, I should therefore advise that it be lowered at Whitney street 20 inches and raised at Susquehanna street 18 inches, and keeping it raised all the way down, so that its soffit will at least be on a level with the soffit of the intercepting sewer on South street.

The depth of sewers customary in your city is ample. In fact, there may be localities where it is too deep to allow of an economical system. For instance, at Main and Chestnut streets. I have placed the bottom of the sewer hardly 5 feet below the surface. To increase it would be to increase as much the depth of the whole sewer to Front street. While this would increase the cost and the difficulty of connecting with it, on the other hand it prevents deep drainage for only a very small area, and where deep cellars would likely not be built. The sewers are also somewhat shallow north of Frederic street for the reason that a deeper drainage necessitates such light gradients that the sewers would continually cause trouble. And to advise other expedients would entail an expense which the small area affected does not justify.

JUNCTIONS AND HOUSE CONNECTIONS.—The sewer junctions are one of the most important details of the work, for it is here where the deposits are most likely to occur, and in decomposing, to foul the air of the entire sewer. Their design should receive careful consideration. The lower half of the sewer should be made to run through the manhole, instead of continuing the custom in your city of forming a basin in it, which always causes a deposit of foul matter. Pipe sewers should be joined by curves situated entirely within manholes, so that the sewers themselves can be sighted. The resistance due to the bend is compensated by an extra fall when turning.

Branch pipes for house connections should be placed into the sewers when built, and if not used, temporarily closed. They must enter the sewer near the top and be set at an angle to prevent retardation of flow.

MAN AND LAMP HOLES.—An essential part of every sewerage system is a provision for examining and cleaning it when necessary. In spite of the greatest care and preventative measures, stoppages or accumulations in sewers will occur. It is then necessary at once to discover the location of the trouble and to remove it before the sewage backs up into the houses. Man and lampholes placed at not too distant points readily permit of this. The lampholes are inexpensive, being simply a small pipe carried to the surface into which a lamp can be lowered to be sighted from a manhole. The latter must be large enough for a man to enter. The smaller the pipes the closer as a rule, should be the points of access. I have placed them on the plan about as frequently as long experience has shown to be desirable.

CATCH BASINS.—A rapid flow of water in the street gutters suspends and carries along a large amount of silt and rubbish which if entering the sewers would be likely to deposit. A catch basin of sufficient size is therefore required at every inlet. The designs now in use in your city are quite suitable for the purpose, although the size of the basin might advantageously be increased

at the foot of steep slopes. I have marked catch basins on the plan at all places where from the nature of the surface they would probably be necessary. Where several are noted at a crossing, one or two might be temporarily omitted, and the water taken across the street in box culverts. I have not marked basins on streets near the rivers, as there would be no doubt at such points as to where to discharge them.

SUBSOIL DRAINAGE.—An important factor in sanitary drainage is the removal of the subsoil water from near the surface and the keeping of it as much as possible on a constant level. You have little trouble from this source, as the soil is very porous; yet I should advise that, in the depressions near Main and Chestnut streets and along the low side of Henry street, small tile drains be laid into the sewer trenches over the pipes and discharged at the next manhole. Considerable moisture will always gather at these localities, and as the sewers must be water tight to prevent soakage into the soil, this mode of removing excessive moisture is very advantageous and economical.

MAINTENANCE.—A system of sewers, to remain in good working order, requires at times inspection and cleansing. It is impossible to prevent the occasional entrance of substances that will obstruct the flow, and if not removed by a powerful flush of water concentrated upon the particular part of the sewer, will finally cause a complete stoppage. Experience with the sewers will soon tell how often an inspection of the different sewers is necessary to avoid serious accumulations.

Catch-basins should be regularly cleaned after every rain, to guard against their being filled up with silt at the beginning of a sudden storm.

The flushing of the sewers is best accomplished, first, by automatic flush-tanks at the dead ends, where the sewage flow is slight and a more frequent flush is advisable, or by allowing the contents of a watering cart placed over the end of a sewer, at which in this case simply a lamp hole is built, to suddenly descend into it.

Secondly, where this quantity of water lower down the sewer becomes insufficient to accomplish the desired effect, the sewage itself is dammed up by placing a plug in the outlet of a man-hole, and drawing it when enough water has accumulated. In this way sewers can be thoroughly cleansed when necessary. Properly shaped large sewers can be flushed as well as smaller ones.

The ventilation of the sewers should be accomplished by giving access to the outer air at all manholes. This method is now acknowledged to be entirely unobjectionable, if the sewers are well designed and built, and it is by far the least expensive. To aid the ventilation, especially in winter when the manholes are covered with snow, it is customary in cold climates to ventilate sewers also through private house pipes which are extended beyond the roof. This can however only be advised when the house sewerage is properly designed and built, as otherwise the inhabitants might at certain times receive the sewer air into their rooms.

GENERAL REMARKS.—In planning a system of sewerage for your city it was my aim to design the work as much as possible to allow of its gradual extension as needed. I have placed sewers on all streets in the principal parts of the city where they may be of use. This does not of course imply that I should recommend the immediate construction of all at the present time. Many may not be wanted for years.

The early future seems to require the following main lines :

In the Second, Third and Fourth Wards—

1. The main sewer on Hawley and Carroll streets.

2. The extension of the main sewer on State street to Lewis street, thence to

Prospect avenue, thence to Eldredge street, and thence to Robinson street. This will permit a large and important territory to be readily connected with it by 8-inch pipes, whenever desired, as Washington street and others.

3. The main sewers on Susquehanna and Hawley streets, between State and Exchange streets, which also control an important area both for stormwater and sewage removal. By branching from it with 8-inch pipes, Exchange street and others can be drained.

4. The construction of the South street intercepting sewer, first from its mouth to State street to prevent the fouling of the flats in front of the tannery, thence to Carroll street, when the sewage of the latter becomes objectionable in the river, or continuing it as far as Henry street, when the district to be sewered to this point requires a proper outlet.

5. The Henry street sewer with the temporary exclusion of sewage until the Liberty street intercepting sewer is built.

In the First Ward—

1. The large sewer from the foot of Leroy street to Chestnut and Main streets, to relieve the troubles from stormwater, as well as to permit a large area to be relieved of its sewage.

2. The continuation of this sewer to the foot of Lovers' Lane.

3. The sewer on Main street from Murray street to the river.

4. The stormwater channel from McLean street to Trout creek.

5. The low level, intercepting sewer from the temporary outfall at Maiden Lane to Winding Way, or still further up.

These sewers control all sections of the city that are at present well built up, or are inconvenienced by heavy rains.

There are a large number of details for the whole system which must be carefully considered, such as the most expedient gradients for the numerous branch sewers, the junctions and heads of sewers, as well as the designs for the overflows,—all of which could not be given in a general report. These points must be considered specially when each sewer is to be constructed, as it will also be necessary to slightly adjust the grades and elevations of the main sewers as marked on the plan, to the exact data obtained from special surveys. Insufficient attention to details has in my experience been the main cause of the unsatisfactory condition of many sewerage works.

It is hardly necessary to add that all existing private sewers not in accordance with the principles embodied in the general design, and not in a position to be brought into connection with it, should be abandoned or rebuilt.

In conclusion I wish to state that a successful system of sewage removal implies not only a judicious design and faithful construction of the street sewers, but likewise a proper plan for the drainage of houses. For if the latter is imperfect, the benefits of the former will be very much diminished. It is therefore advisable to establish certain guiding regulations for this purpose at an early day, to prevent erroneous methods from gaining ground and causing trouble in the future, as it has done in many of our cities.

Respectfully submitted.

RUDOLPH HERING.